Assignment 9

1. A container with total volume, V, is divided into 3 partitions containing, respectively, 1 kmole of He, 2 kmole of Ne, and 3 kmole of Ar (all gaseous). Each compartment is at $T = 300$ K and $P = 2$ atm. The partitions are then removed and the gases diffuse together with no change in temperature. Find,
(a) the final fraction, by number of each gas.
(b) the final partial pressures of each gas.
(c) the change in the Gibbs free energy, ΔG.
(d) the change in the entropy, ΔS.

2. In class we saw how the Gibbs free energy for diamond and graphite changed as a function of pressure (T constant), leading to Fig. 5.15 in the text. [Note that the text uses capital letters even though the tabular values of pages 404-405 are molar specific values.] Assume that the surface temperature of the Earth is 298 K for this problem.
(a) Use another thermodynamic potential and plot g as a function of temperature, T, holding P constant. Let the x axis start at $T = 298$ K. Label the slopes, and values of g on the y intercept for diamond and graphite.
(b) The geothermal temperature gradient in the Earth's lithosphere is $\nabla T \approx 25$ K/km. Find the value of g at 50 km depth for diamond and graphite, ignoring pressure differences.
(c) Compare your results to Fig. 5.15 (see notes). Would you expect diamond to have been formed above or below 50 km depth? Explain.

3. (a) Do problem 5.40 in the text. Assume that the phase boundaries can be represented by straight lines.
(b) The Earth's pressure gradient in the lithosphere is $\nabla P \approx 300$ atm/km (the temperature gradient can be taken from the previous question). At a depth of 50 km, will it be more likely that albite forms or that jadeite+quartz forms? Explain.

4. Do Prob. 6.5 in the text.